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PROJECT VANGUARD REPORT NO. 6

PROGRESS THROUGH JUNE 15, 1956

[~~UNCLASSIFIED TITLE~~] 8

Project Vanguard Staff

342755L

June 28, 1956

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Previous Project Vanguard Reports

Project Vanguard Report No. 1, "Plans, Procedures, and Progress" by the Project Vanguard Staff, NRL Report 4700 (Secret), January 13, 1956

Project Vanguard Report No. 2, "Report of Progress" by the Project Vanguard Staff, NRL Report 4717 (Confidential), March 7, 1956

Project Vanguard Report No. 3, "Progress through March 15, 1956" by the Project Vanguard Staff, NRL Report 4728 (Confidential), March 29, 1956

Project Vanguard Report No. 4, "Progress through April 15, 1956" by the Project Vanguard Staff, NRL Report 4748 (Confidential), May 3, 1956

Project Vanguard Report No. 5, "Progress through May 15, 1956" by the Project Vanguard Staff, NRL Report 4767 (Confidential), June 2, 1956

The administrative report presents a general summary of the progress on Proje
Vanguard with respect to

CONTENTS

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem A02-18

Manuscript submitted June 25, 1956

PROJECT VANGUARD REPORT NO. 6
PROGRESS THROUGH JUNE 15, 1956
[UNCLASSIFIED TITLE]

PREFACE

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent and technical detail is kept at a minimum. It is hoped that the information here provided will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

COORDINATION WITH OTHER SERVICES

Army

The Army has been invited to participate in a passive acquisition program for acquiring the satellite. The system should be a supplement to the Minitrack system and would assume major importance should Minitrack fail to operate because of some failure during the launch operation. The passive nature is required in order to avoid placing additional weight in the satellite.

Air Force

The construction contract for the Vanguard assembly building, Hangar S, was let on 8 June 1956. This should provide a beneficial occupancy date of 1 April 1957. AFMTC has assured Project Vanguard the availability of one half of Hangar C until Hangar S is available.

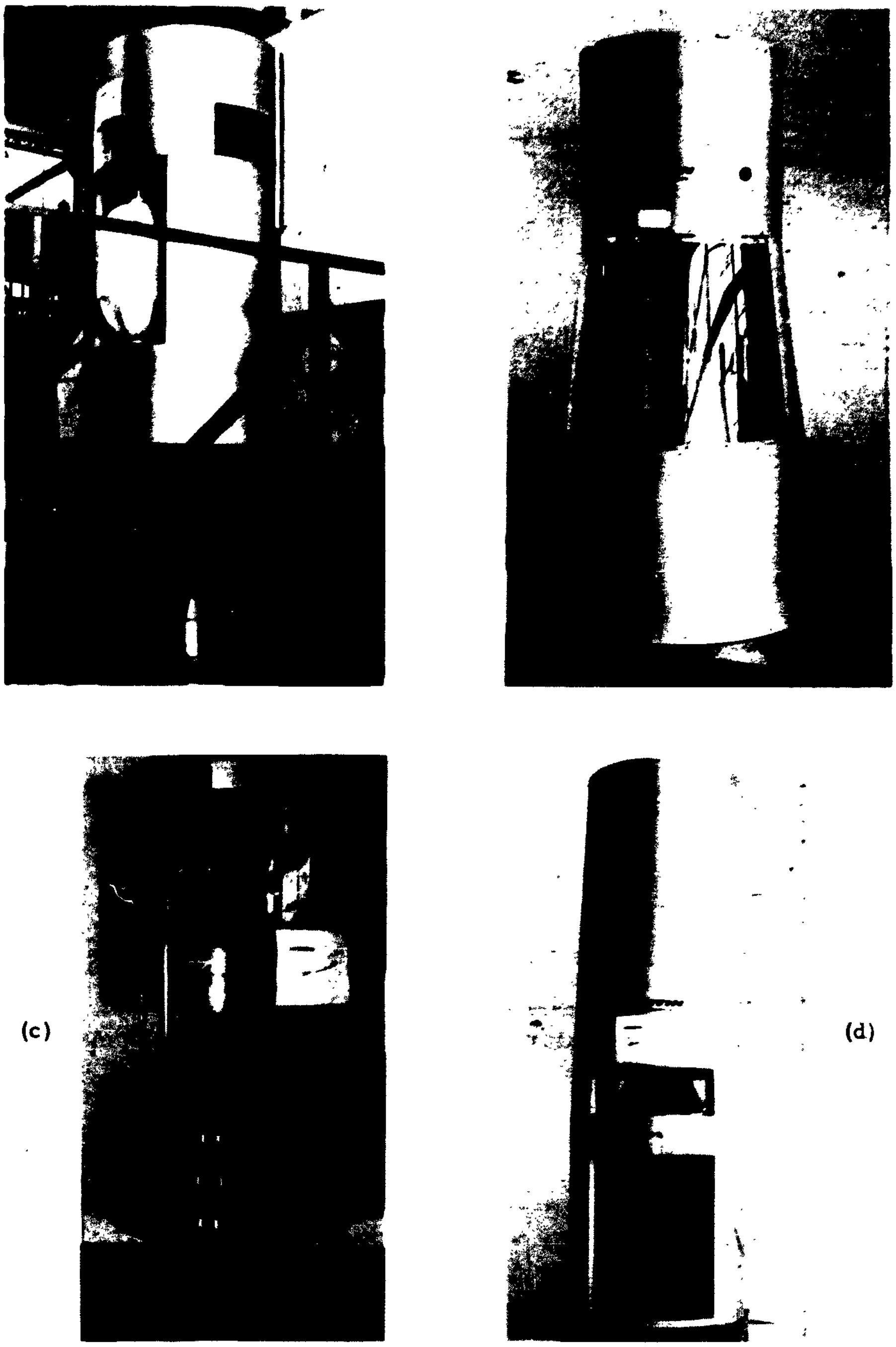
A conference was held at AFMTC with the ARDC Western Development Division and appropriate contractor representatives to determine the details of sharing the space in the blockhouse of the launching facility. A mutually agreeable plan was evolved.

The Viking gantry crane is in the process of shipment to AFMTC from WSPG. A section of track is being readied so that the gantry crane contractor can proceed with the reassembly operation. Some of the minor modifications in platform arrangements of the gantry crane have been approved and will be incorporated in the erection contract.

THE LAUNCHING VEHICLE

The following is the overall vehicle status

1. TV-0 and TV-1 structural design has been completely released to manufacture.
2. TV-2 is 70 percent released.
3. TV-3 is 50 percent released.



(a) (b)

(c) (d)

Fig. 1 - Spatial mockup of the Vanguard launching vehicle (Martin photos). (a) First-stage tail assembly showing thrust chamber with hydraulic actuator, peroxide tank, and external conduit. (b) Interstage structure showing position of second-stage engine and pitch-yaw coasting flight jets. (c) Center and upper second-stage propulsion system with roll control system installed. (d) Control compartment and third-stage section showing spin table and third-stage nozzle base (nose cone removed).

All tools (details and assembly) have been completed for the manufacture of the structural test tail can. The required tooling has been completed for the manufacture of the first-stage dynamic roll model. Also, subassembly and final assembly tools have been completed for the manufacture of the dynamic model for the first- and second-stage test separation.

Configuration and Design

The launching vehicle spatial mockup, made up of the four basic sections shown in Fig. 1, has been completed and displayed. For reasons of simplicity and accessibility the propellant tank sections and the nose cone were not included.

Aerodynamics

Temperature calculations have been completed for external surfaces of Test Vehicles 1 and 2, and the temperature of the satellite sphere has been calculated for various times of nose-cone separation. The optimum time for separation is about 30 seconds after second-stage ignition.

An analysis of the subsonic wind-tunnel data on the Vanguard vehicle shows a generally good correlation between force and pressure measurements. The drag force on the vehicle in a simulated crosswind, however, exceeds that predicted by the use of NACA cylinder data. It is believed, therefore, that a significant Reynolds number effect may be present at the test Reynolds number. It is planned to put the model back in the University of Maryland tunnel in order to define more completely the drag, center of pressure location, lift curve slope, and longitudinal stability in this Reynolds number region.

Structures

A program has been established to obtain vibration environment data from captive firings of all three propulsion systems. This program includes the elastic support and acoustical shielding of the second- and third-stage systems for firings during which these measurements are made. Instrumentation of the first-stage system has started for these measurements, and Martin Company technicians who will assist in these tests have received instruction from NRL in the use of the Mirragraph recording equipment.

Structural element tests have been completed on pressure and axial loadings of the first-stage fuel and oxidizer tank mockup. Pressure tests were carried to ultimate design loads without failure. The axial load test was carried to destruction, and loads equivalent to 106 percent of calculated strength and 250 percent of design ultimate load were sustained. A reduction in tank-wall gage from 0.050 inch to 0.040 inch is structurally feasible and the welding characteristics of the lighter gage and the configuration are being investigated.

Studies have been started to determine the type of material to be used for the first-stage helium spheres. Steel, titanium, and fiberglass are being considered. Steel tanks are being produced for Test Vehicles 2 and 3; however, fiberglass tanks are 25 pounds lighter than steel and may be used for Test Vehicle 4 and later vehicles.

A pressure test of a peroxide tank has resulted in failure of the tank at 75 percent of the design burst pressure. The failure was caused by material strength reduction adjacent to the tank weld. A new heat treatment process will be used in an effort to correct this condition without increasing the gage of the tank.

On the basis of structural limitations, preliminary ground handling procedures and access door usage have been established.

Propulsion

The design of the propulsion fire panel and ground servicing panel has been started. The fire panel contains the major vehicle functions for both the first and second stages. The ground servicing panel contains all of the remotely controlled ground servicing functions, as well as various secondary vehicle functions. Both panels will be used for first- and second-stage static and flight firings.

First Stage

The test firing series with GE demonstrator engine no. 1, the heavy prototype X-405 rocket engine assembly (in Pit 25 at the General Electric Malta Test Station) was successfully completed with a 130-second run following six 30-second runs. It was replaced for further testing by the completely flyable prototype assembly, demonstrator no. 2. The initial run of this unit was terminated after 28 seconds when several injector rings failed. Both the body and the injector of the thrust chamber had accumulated considerable firing time prior to this test.

At present five different injector patterns have been tested in firings of 130 seconds duration. While aluminum is the more desirable material, stainless steel units are also being evaluated.

With the development of an injector design capable of repeatable full-duration operation, the problem of occasional combustion chamber burning has become significant. This occurs as scoring or grooving in the body walls, both near the injector and at the throat. A solution to this problem is being sought along four separate paths:

1. Thinning of the inner shell walls and increased control of manufacturing tolerances
2. Increased local coolant flow velocity in critical regions
3. Coating of the inner wall with a nonmetallic protective layer
4. Further modification of the injector, and increased quality control of manufacturing tolerances

An indication that the first of these has been effective was demonstrated with a thrust chamber with a liner of approximately 0.107-inch thickness which withstood four 130-second runs with no evidence of burning. The fifth run caused slight scoring. The extension of available maximum-run firing time from 130 seconds to 150 seconds may add somewhat to the problem.

As was reported last month, a minor modification had to be made in the thrust-structure assembly as a result of permanent setting under loads greater than 30,000 lb. This modification has been made and the structure satisfactorily passed the 37,000-lb static load test. A structural resonance frequency of 48 cycles per second has been reached, but this necessitated a 33-lb weight increase in the assembly. However, frequency of 43 cycles per second was obtained with a weight addition of only 3.7 lb. Five thrust-structure assemblies have been received and tested to date.

Twelve successful full-duration runs have been made on three prototype turbopump assemblies. These tests were made with water as the pumping medium. The slight cavitation of the oxidizer pump which was experienced in early demonstrator engine runs has been eliminated through refinement of the impeller design.

Some difficulties have been experienced with the latest group of production hydrogen peroxide decomposers received from the vendor; these difficulties have been traced to contaminants in the catalytic screen beds. This situation has been corrected by closer quality control requirements and the affected units are being repaired with no subsequent delays anticipated.

The proper operation of the rocket engine valves and electrical equipment has been basically substantiated in the demonstrator runs.

Second Stage

The problem of low second-stage injector performance as reported last month has persisted. A program to improve this condition has been hampered by excessive ignition delays causing chamber pressure "spiking"* at start-up with resultant damage to the injectors. The inclusion of several unlike-impinging-pair orifices in the showerhead injector has alleviated this problem considerably, and full effort is presently being brought to bear on the more basic performance problem through further injector modification.

Two heavy second-stage propulsion system tank assemblies have been delivered and are scheduled initially for expulsion tests. A prototype pressurizing sphere has been successfully drawn from taper-ground blanks in order to achieve constant thickness.

A hand-welded wire-wound aluminum second-stage thrust chamber has been completed except for rework of the injector for assembly in the chamber. Continuing difficulties in completing the first unit have caused a three- to four-week slippage in the scheduled experimental chamber firing date. Eight experimental thrust chambers are in various stages of fabrication. The thrust chamber fabrication process is illustrated in Fig. 2.

As one phase of a weight-reduction program, the possibility of replacing the present second-stage tankage material, AISI 410 stainless steel, with Armco 17-7 PH steel is being investigated. If no serious fabrication problems are encountered, a weight saving of approximately 35 pounds can be achieved. Regardless of the outcome of this particular investigation, further weight savings in system tankage are anticipated as a result of the careful control to be employed in the manufacture of the tank assembly to keep tolerances on material thicknesses at a minimum.

A one-dimensional heat-transfer analysis has been made for the prototype second-stage thrust chamber assembly. A small positive-cooling safety margin was shown to exist throughout the chamber for the 110°F propellant inlet temperature used in the calculations. This safety margin will increase for the coolant inlet temperature that is presently specified, 60°F.

An analysis has been made of side forces which could result from helium flow into the second-stage thrust chamber in the event of coolant-tube burnout following oxidizer

*Spiking is the term applied to the rapid peaking and subsequent decay of pressure prior to the establishment of the nominal combustion chamber pressure level.

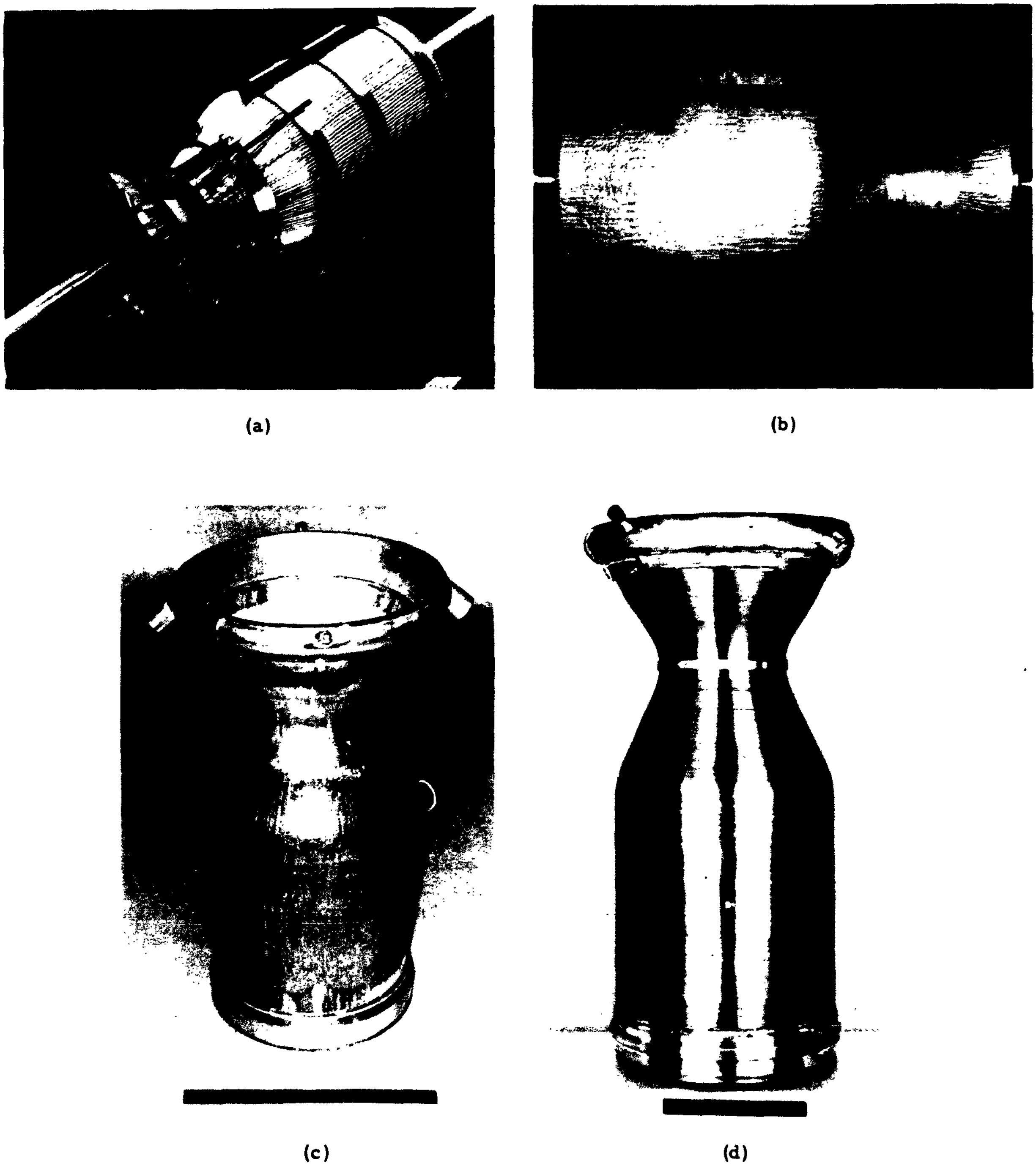


Fig. 2 - Fabrication technique of the aluminum Aerojet-General second-stage "spaghetti" type thrust chamber (Aerojet photos). (a) Precontoured tubes strapped to mandrel ready for welding. (b) Tube welding completed. (c) Coolant manifold attached. (d) Wire winding completed (square cross-section wire).

exhaustion. These calculations indicate that the side impulse that could occur would not exceed 5 lb-sec applied normal to the thrust axis at a point 28 inches aft of the gimbal.

An analysis has been made of the acceleration head of the second-stage propellants during flight, and the resultant effects causing variations in the propellant mixture ratio. It was determined that the overall variation in the mixture ratio that could be anticipated during flight operation is of the order of four percent.

The second-stage dynamic and spatial mockups reported last month* are shown in Fig. 3.

Third Stage

The previously stated† numerical designation for the third-stage rocket units was in error. The last term in this designation, indicating the nominal thrust, should be 2350 rather than 4350. Thus, the corrected designations are:

ABL, Model 42-DS-2350
GCR, Model 42-SX-2350

The initial third-stage scaled motor firings have been completed. The Allegany Ballistics Laboratory has completed nine full-duration firings and five partial-duration quench-arrested firings. The purpose of the five quench-arrested firings was to study resonance burning phenomena encountered during the initial nine firings and to finalize the propellant configuration. The Grand Central Rocket Company has fired three scaled (15-inch-diameter) motors to study propellant geometry.

Both contractors are now making full-scale propellant tests utilizing heavy-walled metal parts. ABL has encountered a three-week delay in delivery of fiberglass nozzle assemblies and are presently firing heavy-walled steel assemblies with a sea-level nozzle. Two initial full-scale firings have been made. The first failed at 12 seconds at the nozzle enclosure; the second firing failed at the same place and the failure was attributed to shear stress at the threaded section.

GCR has encountered a delay in the delivery of lightweight components. Three full-scale propellant configurations have been tested with heavy-walled cases and nozzles. Two propellant configurations were used, one of shorter burning duration than the other. The first long-duration propellant web failed in the nozzle entrance juncture after 32 seconds burning time; the second operated for full duration but high temperatures were encountered on the rocket case. Coatings of aluminum oxide and 91LD phenolic resin are being applied internally to reduce outside temperatures. The third firing, of shorter duration and with thicker coatings, revealed lower external temperatures.

Flight Control

Guidance

Minneapolis-Honeywell has completed a breadboarded reference system. The basic packaged unit design has been completed and a spatial mockup supplied. It has been determined that if the unit temperature can be maintained below 50°F at launch, in-flight cooling will not be required.

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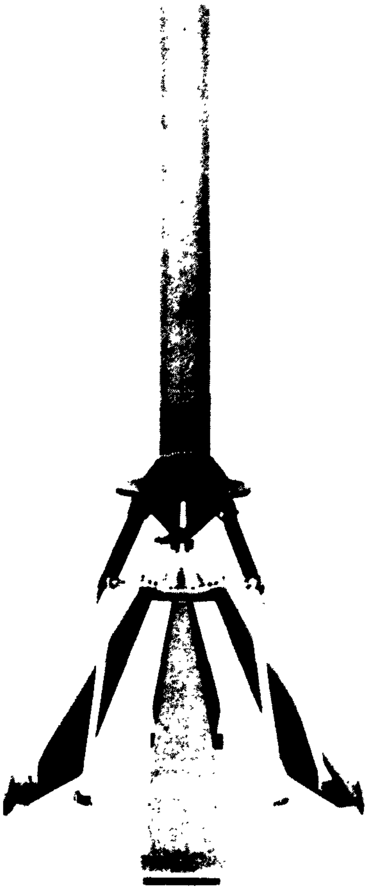
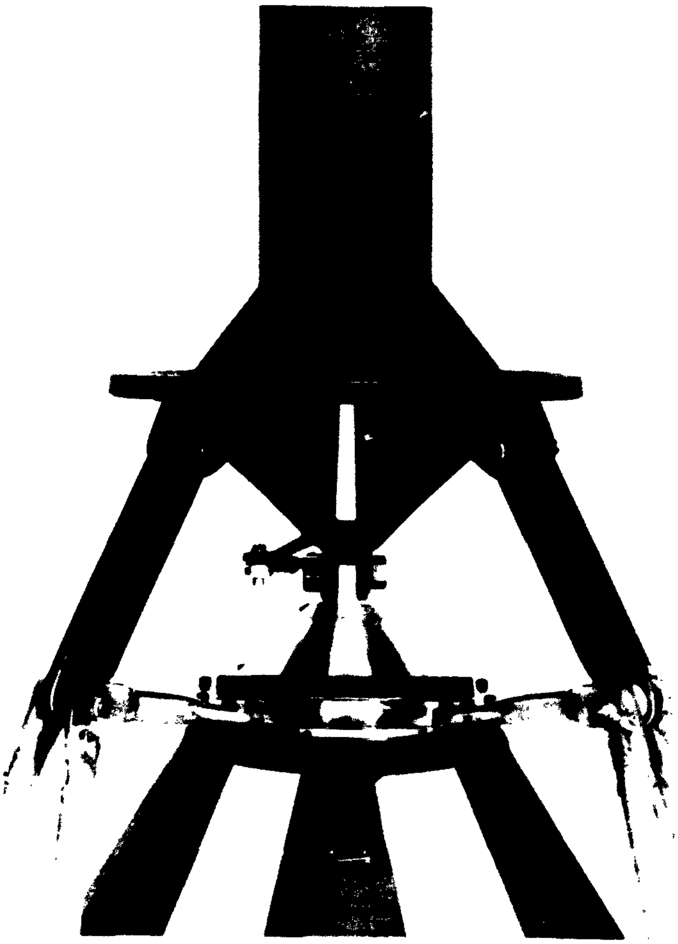
*P.V.R. No. 5, p. 8.

†P.V.R. No. 4, p. 6, and No. 5, p. 9.



(a) Overall view



(b) Close-up showing detail of monoball-clevis construction

Fig. 3 - Second-stage dynamic control mockup (Aerojet photos)

An estimate has been made of the lateral dispersion that might occur because of thrust misalignment and operation of the control jets during the coasting phase of flight. The dispersion is estimated to be less than one degree in azimuth for an apogee range of 800 miles.

Trajectory data based on revised weight information were computed for Test Vehicles 0 and 1. Minimum, nominal, and maximum estimated propulsion system performances were included. For TV-0, a constant pitchover rate of 0.25 degree per second from 10 to 85 seconds is required to obtain a nominal impact range of 170 miles. For TV-1, a constant pitchover rate of 0.25 degree per second from 10 to 28 seconds is required. Similar computations have been initiated for TV-2. The computations include effects of the earth's rotation and re-entry into the atmosphere.

Attitude Control

The Vickers autopilot magnetic amplifier breadboard is to be shipped to Martin on 13 June for inclusion in control system dynamic testing. The design will incorporate approximately 28 modular units made up of reactor, rectifier, resistor, and capacitor elements. The modular units weigh about 3.2 ounces each. The previously considered notch filters have been replaced with a low-pass filter with 50-to-1 attenuation at 8.6 cps and 6 degrees phase lag at 3 cps.

Preliminary tests have been completed on the first-stage tail-can dynamic mockup, utilizing a modified Viking amplifier and servo; later tests will be performed with a Vanguard amplifier and servo. Also, transient response runs were obtained. A desk computer was utilized to simulate the missile transfer function. Transient responses were obtained for the launch, maximum dynamic pressure, and burnout conditions of the first stage. A close correlation existed between the transient responses obtained on the mockup and those obtained in a previous REAC program.

A digital study of the launch of the Vanguard vehicles was completed. It was determined that the first-stage nozzle exit will clear the launch stand if the surface winds (including gusts) are less than 32 miles per hour, and if the engine remains in the neutral control position. If the engine is assumed to be hard over (δ = 7 degrees), the allowable surface wind is reduced to 24.5 miles per hour. Effects of engine controls, thrust build-up with time, and thrust misalignments were included.

REAC programs have been established to verify the analyses of the first- and second-stage roll jet systems and the second-stage pitch-yaw jet system. An additional program has been established to check these systems and the first- and second-stage pitch-yaw motor system, utilizing the electronic autopilot amplifiers. A rigorous REAC program has also been set up to check the structural feedback problem on the Vanguard vehicle.

Staging

An investigation of the effects of delayed second-stage ignition* upon overall vehicle performance has been completed. The resulting projection velocity penalties for the

*P.V.R. No. 4, p. 10.

launching vehicle system described in the specification (NRL 4100-1), assuming that the first stage is separated at burnout, were as follows:

Delay between first-stage burnout and second-stage ignition (seconds)	Decrease in satellite projection velocity (feet per second)
15	390
30	851
45	1366

The final design approach to the second-stage launch phase has not been decided on.

The third-stage launch sequence will have the following characteristics:

1. The third stage will be spun up while mounted on the attitude-oriented second stage, near the peak of the ascent trajectory.

2. When nominal speed has been reached, separation will be effected by firing retro-rockets (braking rockets) on the second stage.

3. When sufficient clearance occurs, the third-stage rocket motor will be ignited and the rocket will be spin-stabilized through its burning period.

Electrical System

The drawing for the purchase of the flight batteries for TV-1 and for laboratory testing has been released. Drawings for the installation of the battery in TV-1 also have been completed. Destruct circuitry schematics for TV-2 have been completed, and the destruct panel design is ready for release to manufacturing. The main power supply battery for TV-2 has been ordered, and installation provisions for this battery have been completed.

Hydraulic System

The first-stage pitch and yaw hydraulic actuators have been designed and released for production. The drawings for the first-stage reservoir, and installation drawings of the first-stage hydraulic system are also complete. The pitch and yaw hydraulic actuators for the second stage have been manufactured and are ready for installation in the dynamic mockup. Procurement specifications have been prepared for the second-stage hydraulic components. Layouts of the hydraulic system have been completed and the installation is being tried out in the spatial mockup.

Vehicle Instrumentation and Tracking

Telemetering

General

In order to comply with anticipated AFMTC requirements for heavier emphasis on closed-loop telemetry checkouts, Vanguard is requesting AFMTC to provide a fixed telemetry trailer site approximately 4000 feet from the launcher at any azimuth angle between 265° and 345° true. Coaxial cable would be used directly from the rocket equipment to the ground stations, thus permitting extensive checkout without any interference to other agencies. Open-loop radiation would be limited to systems checks utilizing the rocket antennas for separate discrete time intervals, which are considered essential.

Ground power supplies for remote activation of rocket telemetering equipment have been constructed for Martin plant use and are awaiting checkout.

AFMTC has tentatively agreed to purchase six three-element helix antennas from the New Mexico College of Agriculture and Mechanic Arts through NRL to support Vanguard needs for high-gain telemetry antennas at the downrange island stations.

The new ONR-sponsored antenna contract with the New Mexico College of Agriculture and Mechanic Arts became effective on 5 June.

An agreement has been reached with the Douglas Aircraft Company on the allocation of space behind the blockhouse firing rooms for the Vanguard telemetry and range instrumentation monitor equipment. It is proposed to exchange detailed firing schedules to determine possible areas of interference.

A communication intercom and telephone net has been worked out jointly by Martin and NRL for submission to AFMTC as a Vanguard requirement.

Ansco Plenachrome and Gevaert film are being investigated as replacements for Eastman Verichrome which has been discontinued. The film is required for ground station recording purposes.

Partial delivery of Silvercel batteries for telemetering and range instrumentation needs has been made. Battery boxes have been designed and constructed, and assembly and wiring are underway. Sample battery boxes have been sent to the Martin Company.

PPM/AM Systems

Work is progressing on the ppm/am vehicle telemetering transmitters. A prototype rf oscillator, redesigned for better neutralization, is showing good promise.

The first Elsin Electronics Corporation ppm/am ground station has been received, less recording magazines, and is being tested. Shipment of the magazines is expected shortly. Construction of a ppm/am ground station by NRL for Martin plant use has been completed and the station is being checked. Instruction of Martin personnel in the use of the ppm/am ground station has been initiated.

Four ppm/am calibrators have been delivered and sent to the NRL Model Shop for wiring and adjustment. Six low-noise insertion amplifiers for ppm/am receivers have been delivered by the NRL Model Shop but are not yet checked out; one is now being evaluated.

PWM/FM Systems

Vibration checks have been conducted on the pwm/fm transmitter package for TV-0, and a flight unit is being prepared for shipment to the Martin plant.

Preparations are being made to conduct systems tests on the pwm/fm ground station prior to trailer installation.

FM/FM Systems

A contract for five fm/fm vehicle telemetering transmitters has been let to the Hoover Electronics Corporation. However, Hoover has reported a potential delay in manufacture of the transmitter prototype due to long delivery time of a subcomponent, the crystal-controlled oscillator. Efforts are being made to borrow one oscillator for prototype construction from some other agency; meanwhile, a priority statement is being prepared for transmission to the INSMAT representing the manufacturer's area.

BuAer has granted NRL's request for the loan of an AN/UKR-5 fm/fm and pwm/fm ground station for laboratory checkout of transmitters. The unit is scheduled for delivery to NRL between 15 and 31 July.

Range Instrumentation

Three AN/DPW-1 radar beacons have been received from WSPG. One beacon was tested and shipped to the Martin plant on June 15, 1956. Work is continuing on the remaining beacons.

Work by Melpar is expected to begin immediately on the AN/DPN S- and C-band radar beacon (Melpar 1245) for the Vanguard program.

An investigation of improvements in the AN/DPN-19 for third-stage vehicle tracking is essentially complete. One beacon will be modified and tested to Vanguard environmental specifications.

Permission has been obtained from the Army Signal Corps to approach the Hazeltine Company directly for procurement of the AN/DPN-31 radar beacons for first-stage vehicle tracking. A formal request for a proposal has been sent to the Hazeltine Company.

Environmental tests on BRL's DOVAP transponder are expected to begin during the week of 18 June 1956. If tests are satisfactory, one unit is expected during the test week. The delivery of DOVAP equipment to Vanguard has been delayed because of late delivery of high-voltage power supplies. The delivery of DOVAP test equipment from BRL is expected during the test week.

Range Safety

Six AN/ARW-59 range safety command receivers and decoders have been received, and test and modification of these units has begun. This is partial shipment of 15 receivers and 10 decoders ordered from the Bureau of Aeronautics for the Vanguard test program.*

A meeting with the Collins Radio Company and the Bureau of Aeronautics has been set for 21 June 1956 to discuss specifications of the Vanguard mission vehicle receiver and to obtain information regarding the delivery schedule and cost.

AFMTC has agreed to provide the use of a 2-pen plotting board at the central control station; this is to provide $\dot{x}$ vs $\dot{h}$ and $\dot{y}$ vs $\dot{h}$ flight-path-trimming ground command.

*P.V.R. No. 4, p. 13, and No. 5, p. 15.

A range tracking and monitor ground control rack and power supply has been designed and constructed and shipped to the Martin Company. A second rack for the hangar laboratory at AFMTC is nearly complete. Construction of control and monitor racks for the blockhouse has begun.

The New Mexico College of Agriculture and Mechanic Arts has been requested to design helix antennas for the blockhouse DOVAP monitoring equipment.

THE SATELLITE

Configuration and Design

Models of the 20-inch satellites* are being constructed of 0.20-inch 6061 aluminum alloy for structural tests; one of these models is about 60 percent complete. Pressure tests will be made on the pressurized zones, and vibration tests on the entire package. A completed mockup of the internal structure for a 20-inch satellite has been compression tested and found adequate; after a 20-inch shell has passed pressure tests this structure will be installed and tests will be conducted on the whole unit.

A second 6-inch model* with spring-actuated antennas (see below) has been completed. The skin material was changed from 1100 aluminum (2S) to 5052 S aluminum, and the two hemispheres were joined at the equatorial axis instead of the polar axis as with the first model. The new method of fabrication was employed in order to check the fabrication techniques which will be employed on the 20-inch models.

Work on the telescoping powder-actuated antennas has been discontinued, as there appears to be no practical means of checking the operation of the Minitrack transmitter prior to launching if these antennas are employed. Eight more spring-actuated antennas have been completed; four will be installed in the second 6-inch satellite model and the other four are intended for the 20-inch model. Several types of potting compounds are being tested to determine which is most suitable for installing the satellite antennas.

Some proposals for the separating device have been received and are being evaluated, but a final decision must await the receipt of the remaining proposals. Bids on satellite fabrication were requested from the Dow Chemical Company and from Brooks and Perkins; to date, only Brooks and Perkins has replied.

Environmental Studies

Studies have continued on means of regulating the temperature of the satellite instrument compartments despite large variations in skin temperature. The bellows-type thermal diode† has been built and is awaiting adjustment and tests; adjustment is difficult because the device must be removed from the evacuated chamber to change the control point, and this interrupts the temperature cycling. As alternatives to the bellows, bimetallic strips and cupped discs are being considered for a thermal switch application; design based on these methods is awaiting the results of tests on the conductivity of thermal contacts.

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*P.V.R. No. 4, p. 14.

†P.V.R. No. 5, p. 16.

Instrumentation

Work is progressing satisfactorily on the satellite telemetry coding system.* A study is being made of circuit details to optimize weight, power efficiency, accuracy and system reliability.

The first samples of magnetic laminations for nondestructive readout of stored information† have been heat-treated at the Naval Ordnance Laboratory and returned to NRL. A sample unit has been fabricated and is now undergoing laboratory study.

A meteor collision detector was installed in Aerobee-Hi rockets No. 39 and No. 42. No information was obtained from No. 39 because of engine failure, but a complete telemetering record was obtained during the flight of No. 42. An analysis of the telemetering record indicates that the microphone which was used as a transducer was subjected to disturbances that gave a detector output of a random character. A meteor collision count is not obtainable from the telemetering record since it is impossible to state accurately which of the output indications are caused by meteor collisions and which are due to undesired disturbances. Miniaturization of the meteor collision detector is being undertaken, and a search is being made for a transducer which will be suitable for use in a space vehicle.

The Minitrack system is discussed in a separate section of this report.

THE MINITRACK SYSTEM

Specifications to be used in the procurement of 10 Minitrack ground station units have been sent to 13 prospective contractors who were chosen on the basis of their capabilities to produce the volume of units required within an eight-month period, as well as to provide emergency field service at overseas stations in case of equipment trouble. In general, companies having over 1000 electronics employees were chosen.

The specification covered the general requirement applicable to the design and construction of the complete ground station assembly of the Minitrack system, exclusive of the ground antenna arrays and the antenna feed lines. The following items were covered:

1. RF transmission line terminal box, with pressure monitor
2. RF receiving rack and power supply rack
3. Phase measurement rack and power supply rack
4. Precision time standard rack
5. Analog recorder unit
6. Digital recorder unit
7. RF test equipment rack
8. Phase measurement test equipment rack

*P.V.R. No. 3, p. 16, and No. 5, p. 17.

†P.V.R. No. 5, p. 17.

The contractor will be responsible for the modification of commercial trailers (to be supplied as government-furnished equipment) to contain all of the above items as a unitized package. Assuming a contract date of not later than 15 July 1956, the contractor shall furnish two personnel to work with the NRL staff beginning 1 August 1956 in the test and evaluation of the NRL prototype ground station unit at the Blossom Point Test Station, in order to acquaint the contractor with the design criteria and operational characteristics of the Minitrack system. The release of all system components for production shall be accomplished by 1 October 1956, with delivery of units on a one-per-week basis starting not later than 1 May 1957.

Following the mailing of the invitations to bid, a bidders conference was held at NRL on 13 June 1956, at which time a detailed description of the Minitrack ground station units was given, and the prototype unit was shown for detailed inspection by the prospective contractors. Of the 13 invitees, nine companies sent representatives to this conference; this is considered a very good percentage considering the time schedule involved. Ground station prototype unit made at NRL is completed and is undergoing initial unit tests at the present time. The complete time-standard phase-measurement combination has been on test since 4 June, and the RF rack since 14 June. Complete system tests are to be completed by 25 June. The trailer van to house this unit at the Blossom Point Test Station is currently undergoing modification, including the addition of an air conditioner and a rack-ducting system. This unit is also scheduled for completion by 25 June, and the Minitrack ground station racks are scheduled to be installed and the trailer hauled to Blossom Point by 5 July; operation at Blossom Point is scheduled for 9 July.

The Blossom Point Test Facility, although behind the 1 June completion date, is now nearing completion. As was stated above, operation of the prototype ground station unit at Blossom Point is scheduled for 9 July; all components, including antennas and rf feed lines, will be available at this date. The schedule for the completion of this test station is now as follows:

Antenna piers and trailer pad complete	22 June
Prototype ground station unit complete	25 June
Trailer van modifications complete	25 June
Taco antenna delivery	27 June
D. S. Kennedy antenna delivery	27 June
RF transmission line delivery	2 July
Power, water, phone, etc.	2 July
Prototype unit tests in trailer complete	5 July
Antenna installation complete	9 July
RF transmission line complete	9 July
Administration building complete	9 July
Station operation	9 July

Contracts for the building and for the concrete antenna piers and pads have been let, with completion scheduled as above. Land clearing and establishment of the access road is complete. Water, power, phone, and sanitary facilities are to be completed by 2 July.

In the last Progress Report it was stated that the altitude obtained during the flight of Aerobee-Hi No. 42 was about 117 miles. Inasmuch as this altitude was too low to provide the basic information desired on this flight, namely the measurement of the effect of the ionosphere as a source of phase noise to the Minitrack system, arrangements were made to fly the same experiment in Aerobee-Hi No. 50, scheduled for 26 June 1956. This flight was also to carry a 46-Mc ionosphere experiment for the Ionosphere Section of the Rocket Sonde Branch of NRL, which would also feed a simulated Minitrack ground receiver unit at this frequency. Owing to rocket operational difficulties associated with Aerobee-Hi No. 46, the 108-Mc Minitrack experiment, which in this rocket represents 10 pounds of payload, has been withdrawn to allow a less powerful propulsion system to be used in Aerobee-Hi No. 50. The 46-Mc data will be made available to Vanguard, however, for extrapolation to 108 Mc. As a result of this decision, it may be necessary to add a Minitrack experiment to Vanguard Test Vehicles TV-1 and TV-2.

An article entitled "Radio Tracking of the Earth Satellite," by Roger L. Easton, describing the Mark II Minitrack system, will appear in the July issue of the magazine QST, the official magazine of the American Radio Relay League. This issue will be available on 25 June 1956.

A typical final design of a transistorized Minitrack transmitter of 16 milliwatts output at 108 Mc is now undergoing life tests. This unit includes seven RM-12 Mallory mercury batteries, sufficient for at least two weeks of operation. The total weight of the unit is 13 ounces.

As described in Project Vanguard Report No. 1, the satellite telemetering system would involve a turn-on receiver within the satellite package to turn on the scientific instruments, the telemetering coder, and the high-power modulated Minitrack transmitter, as well as to switch the antenna from the low-power transmitter to the high-power transmitter. In the interest of simplicity and possible higher reliability, it has been suggested that the experimental groups so design their equipment as to make continuous operation possible without the need for a periodic turn-on signal. The experiments planned by NRL have therefore been redesigned to run continuously for two weeks. As a result, the NRL experimental satellite packages will operate continuously without the need for turn-on receivers. However, inasmuch as a prototype telemetering system has been guaranteed to the NAS-IGY agencies providing scientific experiments within the satellite, telemetering ground turn-on transmitters at each Prime Minitrack Station and turn-on receivers within the satellite will be provided as required for their flights.

DATA PROCESSING

Telemetered Data

The requirements for an automatic recording and reduction facility (ARRF) for telemetered data were prepared by NRL and sent to several possible contractors by the Office of Naval Research (Negotiations Branch) on 6 June 1956. The detailed requirements for equipment and maintenance-operating services were discussed at a meeting on 14 June 1956 at ONR for the information of interested companies. Proposals are to be submitted for receipt at ONR on 29 June 1956. It is expected that the ARRF system can be supplied within six months from the date (probably some time in July) of the contract.

The ARRF system will quantize the ppm/am data and record it on magnetic tape in digital form during a flight. The pwm/fm and fm/fm video data will be recorded on magnetic tape in the conventional manner during a flight but will be transcribed afterwards to digital form on magnetic tape by playback through the NRL-supplied ground stations combined with the ARRF system. After the flight, the digital recordings can be used in the ARRF system for the automatic preparation of linearized time-history graphs and of numerical data (in tabulated form and in punched-paper-tape form) for computations on the NAREC.

Orbital Data

Between 17 May and 13 June 1956, several negotiating conferences were held with the International Business Machines Corporation by NRL and the ONR Negotiations Branch to complete the details of the contract for the digital satellite orbit computing facility.* It is expected that the contract will be signed by IBM and the Navy before 1 July 1956.

*P.V.R. No. 2, pp. 13-14.

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